PLANT ITEM MATERIAL SELECTION DATA SHEET

R10682507

UFP-FILT-00001A/B, 2A/B, 3A/B (PTF)

Ultrafilter

ISSUED BY
RPP-WTP PDC

- Design Temperature (°F)(max/min): 200/59
- Design Pressure (psig) (max/min): 200/0
- Location: outcell

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:

- The vessel is always alkaline, within the stated limits, at the normal operating temperature.
- The vessel will be cleaned using 2 M HNO_3, 2M caustic or process condensate at normal operating temperatures; the condition of high temperature and acid is not examined.

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 316 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.016 inch erosion allowance)

Process & Operations Limitations:

- Develop rinsing/flushing procedure for acid and water

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This bound document contains a total of 7 sheets.

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Corrosion Considerations:

a General Corrosion

Hamner (1981) lists a corrosion rate for 304 (and 304L) in NaOH of less than 20 mpy (500 µm/y) at 77°F and over 20 mpy at 122°F. He shows 316 (and 316L) has a rate of less than 2 mpy up to 122°F and 50% NaOH. Dillon (2000) and Sedriks (1996) both state that the 300 series stainless steels are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above.

Davis (1994) states the corrosion rate for 304L in pure NaOH will be less than about 0.1 mpy up to about 212°F though Sedriks states the data beyond about 122°F are incorrect. Danielson & Pitman (2000), based on short term studies, suggest a corrosion rate of about 0.5 mpy for 316L in simulated waste at boiling, >212°F. In addition, Zapp (1998) reports that the Savannah River Site evaporator shells have successfully operated for 30 years at temperatures of about 300°F; 304L heat transfer tubes have survived only about 10 years.

In this system, the normal hydroxide concentrations and temperatures are such that 304L stainless steel will be acceptable.

The proposed acid cleaning requires an examination of the conditions in the system during that period. Wilding and Paige (1976) have shown that in 5% nitric acid with 1000 ppm fluoride at 290°F, the corrosion rate of 304L can be kept as low as 5 mpy by the use of Al^{+++}. Additionally, Sedriks (1996) has noted with 10% (≈2N) nitric acid and 3,000 ppm fluoride at 158°F, the corrosion rate of 304L is over 4,000 mpy. Therefore, there is a concern about excessive corrosion rates during acid cleaning especially in the pores of the filters unless the free fluoride concentration is kept low – even small amounts of corrosion can change the filter characteristics. Keeping the vessel as cool as possible, below 100°F if possible would reduce the extent of attack by chloride (pitting and crevice corrosion) and, and with the addition of Al^{+++}, general corrosion due to fluoride. At the stated temperature and fluoride complexants, such as Al^{+++}, 304L would be suitable, provided there is strict control of the acid cleaning conditions. 316L would provide a greater margin of safety.

Conclusion:
At the expected temperatures, 304L is expected to be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy. During acid cleaning, in the presence of fluoride, 316L is required as a minimum.

b Pitting Corrosion

Chloride is known to cause pitting in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions, pH>12, chlorides are likely to promote pitting only in tight crevices. Dillon and Koch (1995) are both of the opinion that fluoride will have little effect in an alkaline media. Jenkins (1998) has stated that localized corrosion can occur under the deposits on heat transfer surfaces, probably due to the chlorides. Further, Revie (2000) and Uhlig (1948) note that nitrates inhibit chloride pitting.

Normally the vessel is to operate between 77 and 86°F. At the normal temperature, based on the work of Zapp (1998) and others, 304L stainless steel would be acceptable in the proposed alkaline conditions. There is uncertainty about the behavior of the sintered junctions in the filters in strong caustic.

Under acidic or neutral pH conditions, a more pitting resistant alloy may be needed. Depending on the temperature, concentration of the chloride, and the duration of exposure during acid cleaning it might be feasible to use 316L stainless steel. At a normal operating temperature and only residual chlorides during nitric cleaning, 316L would be acceptable.

If the vessel were filled with process water and left stagnant, there would be a tendency to pit. The time to initiate would depend on the source of the water, being shorter for filtered river water and longer for DIW. Pitting has been observed in both cases, and is likely because residual chlorides are expected to remain.

Conclusion:
Localized corrosion, such as pitting, is common but can be mitigated by alloys with higher nickel and molybdenum contents Based on the expected operating conditions and the intent to use acid washes inside the vessels 316L is the minimum acceptable. The presence of crevices in the filter makes 316L the minimum acceptable material for the filters.

c End Grain Corrosion

End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
Not expected to be a concern.

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d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as a few ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), chloride stress corrosion cracking does not usually occur below about 140°F. With the stated temperature and alkaline conditions, 304L is expected to be satisfactory.

Conclusion.
At the normal operating environment, the alloy recommended is a 304L or 316L stainless with 316L filter tubes to provide added protection from the halides.

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system except as noted above.

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are not conducive to microbial growth.

Conclusion:
MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
The presence of multiple tubes, presumably welded at both ends, is a potential concern. Proper design, using heat exchanger industry standards, will eliminate fatigue and corrosion fatigue concerns.

Conclusions
Not a concern.

i Vapor Phase Corrosion
No significant vapor phase region is expected.

Conclusion:
Vapor phase corrosion is not expected to be a concern.

j Erosion
Velocities within the vessel are expected to be low. Based on 24590-WTP-RPT-M-04-0008, a general erosion allowance of 0.016 inch is adequate for components with solids content less than 27.3 wt%.

Conclusion:
Not expected to be a concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

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m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not applicable.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 2 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of 2 M nitric acid.

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References:

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3. Agarwal, DC, *Nickel and Nickel Alloys*, In: Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
4. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
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CCN 110849
Revised Process Corrosion Data Sheet

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Ultrafiltration feed vessels (UFP-VSL-00002 A/B)
Ultrafilter (UFP-FILT-00001,2,3 A/B), Ultrafiltration pulse pot (UFP-PP-00001,2,3,A/B
Facility PTF Ultrafilter Heat Exchangers (UFP-HX-00001A/B)

In Black Cell? Yes (UFP-VSL-00002A/B only)

Chemicals	Unit[1]	Contract Maximum		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	3.61E+01	4.79E+01			
Chloride	g/l	1.20E+01	1.44E+01			
Fluoride	g/l	1.43E+01	1.72E+01			
Iron	g/l	1.69E+02	1.15E+02			
Nitrate	g/l	2.29E+02	2.63E+02			
Nitrite	g/l	6.66E+01	7.97E+01			
Phosphate	g/l	4.81E+01	5.63E+01			
Sulfate	g/l	2.56E+01	3.06E+01			
Mercury	g/l	1.18E+00	1.67E+00			
Carbonate	g/l	1.05E+02	1.06E+02			
Undissolved solids	wt%	25%	25%			
Other (NaMnO4, Pb,...)	g/l	1 00E-02				Note 4
Other	g/l					
pH	N/A					Note 3
Temperature	°F					Note 2

List of Organic Species:

References
System Description: 24590-PTF-3YD-UFP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: UFP04, UFP17, UFP39, UFP07
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID 24590-PTF-M6-UFP-P0002,3, Rev 1
PFD: 24590-PTF-M5-V17T-P0010, Rev 1
Technical Reports. N/A

Notes:
1 Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. T normal operation 77 °F to 194 °F (24590-PTF-MVC-UFP-00002, Rev 0)
3 Alkaline streams with pH range from approximately 12 to 14
4. NaMnO4 is added for oxidative leaching The other chemicals should not be effected by oxidative leaching.
Concentrations may be lowered, but for conservatism did not change in this datasheet.

Assumptions:
Assume the NaMnO4 addition was 1.1 Mole per mole of Cr.

Correction to note 2: Normal operating temperature in the Ultrafilter is 77°F and the maximum operating temperature is 86°F. Temperatures shown are specific to the Ultrafilter Feed Vessels (CCN 112293).

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24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

4.14.3 Ultrafiltration Feed Vessels (UFP-VSL-00002 A/B), Ultra Filters (UFP-FILT-00001A/B, 2A/B, 3A/B), Ultrafiltration Pulse Pots (UFP-PP-00001A/B,2A/B, 2A/B)

Routine Operations

These two vessels receive the feed from the ultrafiltration feed preparation vessels (UFP-VSL-00001A/B). The feed is then concentrated to 20 % solids by being pumped and recirculated through an ultrafiltration loop. The liquid fraction of the filtered feed is sent to the LAW vitrification facility. The feed containing the 20 % solids is sampled to determine the appropriate treatment steps. Treatment of the solids may include solids washing to remove excess sodium through dilution and ultrafiltration, and/or caustic leaching by adding 19 M NaOH until the solution reaches 3 M, allowing a period of 8 hours for digestion, during which the solution is heated to between 176 °F to 194 °F, and then cooled back to ambient temperature (77 °F). After cooling, the contents are reconcentrated to 20 % solids by ultrafiltration. Ultrafiltration pulse-pots (UFP-PP-00001A/B, UFP-PP-00002A/B, and UFP-PP-00003A/B) are used to perform back-pulsing on the ultrafilter tube units. Back-pulsing may involve adding cleaning chemicals (2 M HNO_3, 2 M NaOH, and process condensate).

Non-Routine Operations that Could Affect Corrosion/Erosion

There is the option to transfer the Sr/TRU solids directly to the HLW blending vessel (HLP-VSL-00028), if necessary.